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COMPARISON OF RESTORATION OF MAJOR MINERAL CONTENTS AMONG DIFFERENT FISH AND OTHER EDIBLE AQUATIC SPECIES, TREATED UNDER DIFFERENT PRESERVING AND COOKING CONDITIONS

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ABSTRACT

Fish are good sources of some important minerals. This study was based on the comparison of mineral contents among different fish and other edible aquatic species namely rohu, katla, prawn, lobster, pomfret and hilsa after preservation up to 15th day in refrigerator followed by subjecting to conventional cooking methods. The mineral contents of cooked fish were significantly lower than in the raw condition. These fish were subjected to conventional cooking methods like open pan dry roasting, boiling, shallow frying and deep frying. The mineral contents had changed from the raw value due to the application of cooking methods. Mineral restoration mainly occurred in both open-pan dry roasting and deep frying method whereas loss occurred in boiling. The study significantly showed that preserved pomfret followed by cooking was beneficial due to adequate iron and calcium restoration up to 14th day among all other fish and edible aquatic species.

KEYWORDS: Calcium, Iron, Edible Aquatics Species, Cooking Methods, Open Pan Dry Roasting, Deep Frying

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Original Article

INTRODUCTION

Fish is consumed mainly as a rich source of protein and minerals. But the nutrient contents change when it is cooked as shown in some studies previously carried out. In one study, three commonly available species of marine fish in Nigeria were subjected to boiling, frying and roasting and the effects of these cooking methods on the fish were observed. The results showed reduced protein and mineral contents for all the fish types [(1)]. In yet another research, amino acid and proximate compositions were determined in six commonly consumed raw and cooked marine fish in Turkey. The changes in amino acid and proximate contents, vitamins and mineral contents were found to be significant for all cooking methods in all fish species [(2)]. Another research showed that cooking methods were also applied for vegetable samples which could be a reference for this present study. Three cooking methods, namely boiling, steaming and stir-frying were used to evaluate the effect on nutrient components of bamboo shoots, resulting in decreased contents of protein, soluble sugar, and ash. Results indicated an appreciable loss in the total free amino acids in boiling method. All procedures were carried out for 10 minutes [(3)]. The effects of five domestic cooking methods, including steaming, microwaving, boiling, stir-frying and stir-frying followed by boiling on the nutrients and health-promoting compounds of broccoli were investigated. The results showed that all cooking treatments, except steaming, caused significant losses of total soluble proteins and soluble sugars and minerals [(4)]. The effects of different cooking methods (boiling, baking, frying and grilling) on proximate and mineral composition of snakehead fish were investigated. The changes in the amount of protein and fat were found to be significantly higher in frying and grilling fish [(5)]. Another study was carried out to determine the changes in

the micro-mineral and macro-mineral composition of common sole (*Solea solea*), striped red mullet (*Mullus surmuletus*) and whiting (*Merlangius merlangus*) throughout the year. The researcher concluded that macro-mineral concentrations in edible parts of fish species were 444–1,559 mg/kg for Na, 1,975–5,130 mg/kg for K, 228–658 mg/kg for Mg, 187–1,105 mg/kg for Ca, and 2,341–7,341 for P respectively **(6)**. The present study is significant due to the comparison of calcium and iron contents among preserved river fish, sea fish and other edible aquatic species (crustaceans) after being subjected to conventional cooking. Cooking methods can cause loss of minerals and the fish that can restore more minerals post cooking is investigated in this study.

- This study aims to estimate the iron and calcium contents of different fish and other edible aquatic species in both raw and cooked conditions.
- This study also aims at finding the restoration of mineral contents after preservation up to 15 days followed by cooking.
- To find the fish and the cooking method that is beneficial in the perspective of mineral restoration is the most important concern of this study.

MATERIALS AND METHODS

- **Sample Preparation and Cooking**

Rohu (*Labio rohita*), *katla* (*Catla catla*) and *hilsa* (*Hilsa ilisa*), each with a length of 25 – 30 cm and weight of 1 kg and pomfret (*Pampus argenteus*) with a length of 12cm and weight of 250–300 g and prawn and lobster with a length of 10 cm, 15cm and weight of 50 gm and 90 gm respectively were obtained from the local fish market in Kolkata. They were kept in a plastic container, transported to the laboratory and washed with tap water several times to remove adhering blood and excessive mucous. Subsequently the fish sample was filleted into two sections and each section was divided into five groups. In the first section one group was left uncooked while the other four were boiled, dry roasted in open pan, shallow fried and deep fried. Boiling was performed at 99–101 °C (water temperature) for 10 minutes. Open pan dry roasting of fillets was performed in a pan at 180 °C for 10 minutes. The frying of fillets was performed in a domestic frying pan of 2 L capacity at a temperature of approximately 180 °C for 10 minutes. Mustard oil was used as the medium for frying. In case of shallow frying, 10 ml oil was used and for deep frying 20 ml. The other section was allowed to preserve up to15 days in the refrigerator at -20^0C. The raw, fresh and preserved samples were then subjected to analysis post cooking on the day of preservation of 1^{st}, 2^{nd}, 14^{th} and 15^{th}.

- **Mineral Contents Analysis**

Mineral contents analyses for homogenized samples of cooked and raw fish fillets were done in triplicate for the estimation of iron and calcium contents, determined by AOAC method. (7)

Estimation of Mineral by AOAC Method after Wet Digestion (7)

Dried sample (500 mg) was taken in a 25 ml volumetric flask and 10 ml of concentrated nitric acid was added in it and kept overnight. After that the volumetric flask was placed on the hot plate and allowed to boil for 8 hours. Then 4 ml of perchloric acid was added in it and boiled until brown fumes from the digestion stopped. After that volume was made up to the mark by double distilled water. Then the solution was used for the analysis of iron and calcium by atomic absorption spectrophotometer (Perkin Elmer)

- **Statistical analysis**

The effect of different cooking methods on the mineral contents of river fish, sea fish and crustaceans was analyzed using Mean and Standard Deviation. One way ANOVA was done for comparing the mineral contents between the raw and cooked samples along with the preservation days up to 15th. Differences were considered to be significant when p value is < 0.05. Data were analyzed by using SPSS package (Version 17).

RESULTS

Table 1: Iron Contents

Name of fish	Duration	Raw	Boiling	Dry roasting	Shallow fry	Deep fry
Rohu	fresh	2.7±0.02	3.16± 0.06	1.67± 0.02	1.49± 0.03	7.06± 0.04
	24 hours	0.38± 0.03	1.08± 0.03	2.05± 0.04	2.43± 0.08	1.07± 0.04
	48 hours	1.38±0.05	0.94±0.03	0.61±0.05	3.95±0.03	4.81±0.03
	14 days	1.51±0.03	2.03±0.05	1.86±0.05	4.55±0.03	1.56±0.03
	15 days	2.82±0.03	1.76±0.07	1.77±0.06	1.62±0.04	1.75±0.04
Katla	fresh	2.83±0.04	1.35±0.06	5.70±0.02	2.41±0.11	4.18±0.05
	24 hours	0.88±0.10	1.08±0.03	1.14±0.02	2.44±0.07	2.55±0.03
	48 hours	0.81±0.08	2.07±0.04	2.14±0.07	3.08±0.03	2.43±0.51
	14 days	1.36±0.06	3.04±0.03	1.02±0.09	1.44±0.03	4.64±0.12
	15 days	*1.19±0.06*	*1.44±0.02*	*1.82±0.09*	*4.98±0.07*	*1. 68±0.05*
Prawn	fresh	1.40±0.02	1.45±0.03	1.51±0.01	0.93±0.02	0.68±0.06
	24 hours	2.51±0.01	1.81±0.08	1.77±0.04	3.36±0.06	2.46±0.04
	48 hours	1.58±0.06	1.36±0.05	2.06±0.02	2.31±0.03	2.29±0.08
	14 days	4.05±0.04	3.45±0.04	4.45±0.09	1.54±0.02	1.56±0.02
	15 day	3.15±0.06	2.15±0.13	1.42±0.02	2.65±0.03	2.83±0.04
Lobster	fresh	2.55±0.01	1.65±0.04	4.60±0.02	1.72±0.04	0.90±0.05
	24 hours	0.56±0.02	1.45±0.04	0.95±0.05	1.18±0.03	1.40±0.05
	48 hours	0.90±0.02	0.56±0.02	1.52±0.03	1.02±0.02	1.47±0.04
	14 days	0.62±0.07	1.63±0.05	0.57±0.04	0.70±0.05	1.08±0.03
	15 days	1.18±0.03	1.78±0.03	3.98±0.02	1.52±0.02	1.66±0.02
Pomfret	fresh	2.84±0.00	1.57±0.02	2.09±0.07	1.07±0.05	4.54±0.04
	24 hours	4.93±0.07	4.29±0.04	5.05±0.04	4.54±0.05	4.15±0.04
	48 hours	2.48±0.03	3.25±0.05	3.66±0.04	4.54±0.05	4.66±0.04
	14 days	3.56±0.02	3.05±0.04	1.85±0.03	2.92±0.08	2.92±0.07
	15 days	1.00±0.01	0.75±0.03	1.43±0.03	0.48±0.03	0.32±0.03
Hilsa	Fresh	3.28±0.01	1.28±0.03	2.38±0.26	1.66±0.04	1.82±0.05
	24 hour	3.25±0.05	1.74±0.05	3.22±0.03	2.98±0.04	3.48±0.03
	48 hours	1.87±0.02	1.72±0.03	0.87±0.02	1.78±0.03	1.95±0.04
	14 day	1.56±0.04	2.55±0.03	2.06±0.05	2.12±0.03	1.53±0.04
	15 days	1.56±0.03	2.55±0.03	3.52±0.03	2.56±0.04	2.54±0.05

Table 2: Calcium Contents

Name of fish	Duration	Raw	Boiling	Dry roasting	Shallow fry	Deep fry
Rohu	fresh	161±1.00	272± 2.51	271± 1.06	202± 2.64	434± 4.04
	24 hours	17.50±0.50	3.03± 0.23	5.70± 0.10	5.03± 0.15	7.33± 0.15
	48 hours	223±2.08	106±1.52	121±1.00	352±2.64	437±2.08
	14 days	121±1.00	231±1.00	216±1.52	181±1.52	232±2.00
	15 days	402±2.64	296±2.64	242±3.05	305±4.00	401±1.41
Katla	fresh	152±2.51	62.33±2.51	452±2.64	143±4.16	152±2.00
	24 hours	96±1.52	127±2.08	122±2.51	72±2.51	136±1.52
	48 hours	3.22±2.51	278±2.64	288±2.64	272±2.51	362±2.51
	14 days	52±2.51	301±1.00	66±1.52	203±3.21	531±1.00
	15 days	171±1.00	136±1.52	203±3.21	602±2.51	402±2.64
Prawn	fresh	177±2.08	302±2.00	251±1.00	50±1.00	39±0.25
	24 hours	216±1.52	248±2.64	131±1.00	201±2.08	126±1.52
	48 hours	176±1.52	206±1.52	336±1.00	501±2.08	201±1.52
	14 days	197±2.08	162±2.00	251±1.00	251±1.00	151±1.00
	15 day	151±1.52	502±1.00	152±1.00	291±1.52	185±0.70
Lobster	fresh	241±1.52	271±1.52	241±1.00	201±1.52	151±1.52
	24 hours	201±1.52	262±2.00	161±1.52	123±1.52	151±1.52
	48 hours	169±1.00	262±2.64	166±1.52	125±2.08	152±2.08
	14 days	351±1.00	501±1.00	281±1.00	1.65±2.08	151±1.52
	15 days	133±1.52	153±1.52	252±2.08	141±1.52	236±2.08
Pomfret	fresh	151±1.52	151±1.52	156±1.52	86±1.52	246±1.52
	24 hours	642±2.51	302±2.00	302±0.57	402±2.00	182±2.00
	48 hours	382±2.51	202±2.51	127±2.08	136±1.52	175±3.00
	14 days	195±3.00	297±2.08	417±2.51	185±3.00	243±3.60
	15 days	166±1.52	362±2.51	282±2.00	213±3.21	208±3.21
Hilsa	Fresh	201±1.52	277±2.08	301±1.00	352±2.00	151±1.52
	24 hour	221±1.52	196±1.52	161±1.52	292±2.00	501±2.08
	48 hours	222±2.00	201±1.53	219±1.53	402±2.00	192±2.00
	14 day	232±2.00	302±2.09	332±2.00	352±2.00	202±2.09
	15 days	202±2.00	228±2.08	501±1.53	242±2.52	752±1.53

Table 3: Comparisons of Iron Contents among Different Fish and Other Edible Aquatic Species

Name of fish	fresh	24 hours	48 hours	14 days	15 days
Rohu	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Katla	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Pomfret	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Hilsa	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Prawn	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Lobster	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)

(P value = <0.05 = significantly different) (S= significant, NS= Non significant)

Table 4: Comparisons of Calcium Contents among Different Fish and Other Edible Aquatic Species

Name of Fish	Fresh	24 Hours	48 Hours	14 Days	15 Days
Rohu	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Katla	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Pomfret	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Hilsa	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Prawn	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)
Lobster	0.00(S)	0.00(S)	0.00(S)	0.00(S)	0.00(S)

(P value = <0.05 = significantly different) (S= significant, NS= Non significant)

Table 5: Percentage of Loss of Iron of Different Preserved Fish and Other Edible Aquatic Species

Name of fish	Duration	Raw	Boiling	Dry roasting	Shallow fry	Deep fry
Rohu	24 hours	85.92	65.82	- 22.75	- 63.08	84.84
	48 hours	48.88	70.25	63.47	- 165.1	31.86
	14 days	43.7	35.75	- 11.37	- 205.36	85.69
	15 days	- 4.44	44.30	- 5.98	- 8.72	75.21
Katla	24 hours	68.90	20.00	80.00	- 1.24	38.99
	48 hours	71.37	- 53.33	62.45	- 27.80	41.86
	14 days	51.94	- 125.18	82.10	40.24	- 11.00
	15 days	57.95	- 6.66	68.07	- 106.63	59.80
Prawn	24 hours	79.28	- 24.82	- 17.21	- 261.29	- 261.76
	48 hours	- 12.85	6.20	- 36.42	- 148.38	- 236.76
	14 days	- 189.29	- 137.93	- 194.70	- 65.59	- 129.41
	15 day	- 89.28	- 48.27	5.96	- 184.94	- 316.17
Lobster	24 hours	78.03	12.12	79.34	31.39	- 55.55
	48 hours	64.70	66.06	66.95	40.69	- 63.33
	14 days	75.68	1.21	87.60	59.30	- 20.00
	15 days	53.72	- 7.87	13.47	11.62	- 84.44
Pomfret	24 hours	- 73.59	- 173.24	- 141.62	- 324.29	8.59
	48 hours	12.67	- 119.74	- 75.11	- 324.29	- 2.64
	14 days	- 25.35	- 94.26	11.48	- 172.89	35.68
	15 days	64.78	52.22	31.57	55.14	92.95
Hilsa	24 hour	- 73.59	- 35.93	- 35.29	-79.51	- 91.20
	48 hours	42.98	- 34.37	63.44	- 7.22	-7.14
	14 day	52.43	- 99.21	13.44	- 27.71	15.93
	15 days	52.43	- 99.21	- 47.89	- 54.21	- 39.56

Table 6: Percentage of Loss of Calcium of Different Preserved Fish and Other Edible Aquatic Species

Name of fish	Duration	Raw	Boiling	Dry roasting	Shallow fry	Deep fry
Rohu	24 hours	-15.52	51.83	43.91	26.23	- 53.45
	48 hours	- 38.50	61.02	55.35	-74.25	-0.69
	14 days	24.84	15.07	20.29	10.39	46.54
	15 days	- 149.68	- 8.82	10.70	- 50.99	7.60
Katla	24 hours	36.40	- 104.83	19.73	49.65	10.52
	48 hours	- 111.84	- 348.38	- 89.47	- 90.20	- 138.15
	14 days	65.78	- 385.48	56.57	- 41.95	- 249.34
	15 days	- 12.50	- 119.35	- 33.55	- 320.97	- 164.47
Prawn	24 hours	- 22.03	17.88	47.80	49.65	10.52
	48 hours	0.56	31.78	- 33.86	- 90.20	- 138.15
	14 days	- 11.29	46.35	0.00	- 41.95	- 249.34
	15 day	14.68	66.22	39.44	- 320.97	- 164.47
Lobster	24 hours	16.59	3.32	33.19	38.80	0.00
	48 hours	29.87	3.32	31.12	37.81	- 0.66
	14 days	- 45.64	- 84.87	- 16.59	17.91	0.00
	15 days	44.81	43.54	- 4.56	29.85	- 56.29
Pomfret	24 hours	- 325.16	-100.00	- 93.58	-367.44	26.01
	48 hours	- 152.98	- 33.77	18.58	- 58.13	28.86
	14 days	- 29.13	- 97.35	- 167.30	- 115.11	1.21
	15 days	- 9.93	- 139.73	- 80.76	- 147.67	15.44
Hilsa	24 hour	- 9.95	29.24	46.51	17.04	- 231.78
	48 hours	- 10.44	27.43	27.24	- 14.20	- 27.15
	14 day	-15.42	-9.02	- 10.29	0.00	-33.77
	15 days	- 0.49	17.68	- 66.44	31.25	-398.01

Table 7: Percentage of Loss of Iron of Different Cooked Fish and Other Edible Aquatic Species

Name of Fish	Duration	Boiling	Dry Roasting	Shallow Fry	Deep Fry
Rohu	Fresh	-17.03	38.14	44.81	- 161.48
	24 hours	- 184.21	- 439.47	- 539.40	-181.57
	48 hours	31.88	55.79	- 186.23	- 248.55
	14 days	-33.55	-22.36	- 199.34	- 2.63
	15 days	37.58	37.23	42.55	37.94
Katla	Fresh	52.29	- 101.41	14.84	-47.70
	24 hours	- 22.72	- 29.54	- 177.27	- 189.77
	48 hours	-155.55	-107.73	-280.24	-200.00
	14 days	-123.52	25.00	-5.88	-241.17
	15 days	-21.00	-52.94	-318.48	-41.17
Prawn	Fresh	-3.57	-7.85	33.57	57.42
	24 hours	27.88	29.48	- 33.86	1.99
	48 hours	13.92	-30.37	- 46.20	-44.93
	14 days	14.81	- 9.87	61.97	61.48
	15 day	31.74	54.92	15.87	10.15
Lobster	Fresh	35.29	- 80.39	32.54	64.70
	24 hours	-158.29	-69.64	-110.71	-150.00
	48 hours	37.77	-68.88	-13.33	-63.33
	14 days	-162.90	8.06	-12.90	- 74.11
	15 days	-50.84	- 237.29	- 28.8	-40.67
Pomfret	Fresh	44.71	26.40	62.32	-59.85
	24 hours	12.98	- 2.43	7.91	15.82
	48 hours	- 39.11	- 47.58	-83.06	-87.90
	14 days	14.32	48.03	17.97	17.97
	15 days	25.0	43.0	52.0	68.0
Hilsa	Fresh	60.97	27.43	49.39	44.51
	24 hour	46.46	0.92	8.30	7.07
	48 hours	8.02	53.47	4.81	- 4.27
	14 day	- 63.46	- 32.05	-35.89	1.92
	15 days	-63.46	-125.64	-64.10	-62.82

Table 8: Percentage of Loss of Calcium of Different Cooked Fish and Other Edible Aquatic Species

Name of fish	Duration	Boiling	Dry roasting	Shallow fry	Deep fry
Rohu	fresh	-68.94	-68.32	- 25.46	-169.56
	24 hours	29.56	80.27	19.89	- 8.60
	48 hours	52.46	45.73	-57.84	-95.96
	14 days	- 19.90	78.51	49.58	- 91.73
	15 days	26.36	39.80	24.12	0.24
Katla	fresh	59.21	0.00	5.92	0.00
	24 hours	-32.29	-27.08	25.0	-41.66
	48 hours	13.66	10.55	15.52	-12.42
	14 days	-478.84	-26.92	-290.38	-921.15
	15 days	20.46	-18.71	-252.04	-135.08
Prawn	fresh	-70.62	-41.80	71.75	77.96
	24 hours	-14.81	39.35	6.9	41.66
	48 hours	- 17.04	-90.90	-184.65	-14.20
	14 days	17.76	-27.41	-27.41	23.35
	15 day	232.45	-0.66	-92.71	-22.51
Lobster	fresh	-12.44	0.00	19.90	37.34
	24 hours	-30.34	19.90	38.84	24.87
	48 hours	-55.02	1.77	26.03	10.05

Table 8: Contd.,					
	14 days	-42.73	19.94	52.29	56.98
	15 days	-15.03	-98.47	-6.01	-77.44
Pomfret	Fresh	-70.62	-41.80	-71.75	77.96
	24 hours	-14.81	39.35	6.9	41.66
	48 hours	-17.04	-90.90	-184.65	-14.20
	14 days	17.76	-27.41	-27.41	23.35
	15 days	-232.45	-0.66	-92.71	-22.51
Hilsa	fresh	-37.81	-49.75	-75.12	-24.87
	24 hour	11.31	27.14	-32.12	-126.69
	48 hours	9.4	1.35	-81.08	13.51
	14 day	-30.17	-43.10	-51.72	12.93
	15 days	-12.87	-148.01	-19.80	-272.27

DISCUSSIONS

Table 1 showed the iron contents of *rohu*, *katla*, prawn, lobster, pomfret and *hilsa*. The raw and cooked values according to the days of preservation were displayed here. The iron contents were reduced due to application of different cooking methods. Iron contents were highest in deep frying for *rohu*, *katla*, prawn, pomfret and *hilsa* but it was better restored in open pan dry roasting for lobster. Restoration mainly occurred on 14th and 15th day. Fresh deep fried *rohu* contains most of the iron among all the other fish.

Table 2 showed the calcium contents of *rohu*, *katla*, prawn, lobster, pomfret and *hilsa*. Here also the raw and cooked values were displayed according to the days of preservation. The calcium contents were reduced due to application of heat, water and oil in different cooking methods. Calcium content was highest in deep frying for *rohu*, *katla* and *hilsa*, boiling for prawn and lobster, open pan dry roasting for pomfret but it was better restored in deep frying for *hilsa*. Restoration mainly occurred on 15th day for *rohu*, *katla*, pomfret and *hilsa* but in 48 hours for prawn and 14th day for lobster.

Tables 3 and 4 showed the comparison of the iron and calcium contents respectively of the fish and other edible aquatic species in terms of raw and cooked values according to the days of preservation along with fresh conditions. Data showed that there was a significant difference present in raw, boiling, open pan dry roasting, shallow frying and deep frying methods.

Table 5 exhibited the percentage of loss of iron contents of different preserved fish and other edible aquatic species due to preservation up to 15th day. Most of the iron loss occurred in 24hours for *katla* and prawn, in 48 hours for *rohu*, on 14th day for lobster and *hilsa* but on 15th day for pomfret. On the other hand, maximum restoration of iron occurred in 24 hours for *hilsa*, 48 hours for pomfret, 14th day for prawn and *katla* and 15th day for *rohu* and lobster. Maximum restoration occurred in prawn, *hilsa* and pomfret respectively after preservation up to 15th day.

Table 6 exhibited the percentage of loss of calcium contents of different preserved fish and other edible aquatic species due to preservation up to 15th day. Most of the calcium loss occurred in 24hours for *katla*, prawn, lobster and *hilsa*, in 48 hours for pomfret whereas on 14th day for *rohu*. On the other hand, maximum restoration of calcium occurred in 48 hours for *katla*, 14th days for prawn, lobster, *hilsa* and pomfret and on 15th day for *rohu*. Maximum restoration occurred in *katla*, pomfret and *hilsa* respectively after preservation up to 14th day.

Table 7 exhibited the percentage of iron losses post cooking. Most of the loss occurred in *katla*, lobster, pomfret and *hilsa* after boiling, in *rohu* after open pan dry roasting and in prawn after deep frying whereas open pan dry roasting restored the iron contents mostly in prawn, lobster, pomfret and *hilsa*. Deep frying can also lower the losses in *rohu* and *katla*. Data indicated that open pan dry roasting is useful for iron content restoration whereas boiling can cause losses of iron.

Table 8 exhibited the percentage of losses of calcium content following cooking. Most of the loss occurred in *rohu* and *katla* after boiling, in prawn and lobster after deep frying, in *hilsa* after open pan dry roasting whereas in pomfret after shallow frying. On the other hand boiling can restore the calcium contents mostly in prawn, lobster and *pomfret*. Deep frying can also lower the losses in *rohu* and *katla*. Shallow frying can reduce the loss in *hilsa*. Data showed that boiling is useful for calcium content restoration.

CONCLUSIONS

The maximum iron and calcium contents were found to be highest in *hilsa* and lobsters respectively in raw conditions as well as these were also prone to more loss after cooking, although losses occurred after cooking for all the fish. The iron content was mostly restored in open pan dry roasting for prawn, lobster, pomfret and *hilsa* whereas deep frying helped to restore more iron in case of *rohu* and *katla*. Calcium contents were retained mainly in boiling for prawn, lobster and pomfret where as in deep frying for *rohu* and *katla* and in shallow frying for pomfret. In short, both open-pan dry roasting and deep frying can restore iron and calcium contents in all the fish and other edible aquatic species. Pomfret and *hilsa* restore adequate amount of iron and calcium whereas prawn contains iron and *katla* contains calcium. Most of the fish can be preserved up to 14^{th} day but *rohu*, *katla* and lobster can be preserved up to 15^{th} days. After considering all advantages and disadvantages, it can be said that boiling can reduce the mineral contents and both deep frying and open pan dry roasting can restore iron and calcium almost for all the fish and pomfret is the best among the other fish, regarding the restoration of minerals post cooking. The fish can be preserved up to 14^{th} day.

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REFERENCES

1. *Goldman, K. J. (1997). Regulation of body temperature in the white shark, Carcharodon carcharias. Journal of Comparative Physiology B, 167(6), 423-429.*
2. *Erkan, N., Özden, Ö., & Selçuk, A. (2010). Effect of frying, grilling, and steaming on amino acid composition of marine fishes. Journal of medicinal food, 13(6), 1524-1531.*
3. *Mkandawire, K. T., & Masamba, K. G. (2014). Effect of lemon juice treatment and sun drying on vitamin C retention in three steam and water blanched indigenous vegetables over six weeks storage period. African Journal of Food Science, 8(6), 316-321.*
4. *Yuan, G. F., Sun, B., Yuan, J., & Wang, Q. M. (2009). Effects of different cooking methods on health-promoting compounds of broccoli. Journal of Zhejiang University Science B, 10(8), 580-588.*
5. *Marimuthu, K., Thilaga, M., Kathiresan, S., Xavier, R., & Mas, R. H. M. H. (2012). Effect of different cooking methods on proximate and mineral composition of striped snakehead fish (Channa striatus, Bloch). Journal of food science and technology, 49(3), 373-377.*

6. *J. M. Hungerford & P. Cunniff (1998). Official method 938.08. Ash of seafood. Fish and other marine products. Official methods of analysis of AOAC International, 35(1),6.*

7. *A. S. Baker and R. L. Smith, J. Agric(1974). Preparation of Solutions for Atomic Absorption Analysis of Fe, Mn, Zn, and Cu in Plant Tissue Food Chem. 22, 103.*